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Diseño Gráfico y maquetación
Pedro Verdejo Gimeno
Paula Porta García
Raquel Torres Remón
Irene Palomares Hernández

Diseño Página Web
Pedro Verdejo Gimeno
Serena Motta

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En primer lugar agradecer a los Comités de las anteriores ediciones del Congreso Madrid 2013 Departamento de Construcciones Arquitectónicas de la Escuela Técnica Superior de Arquitectura de Madrid y Florencia 2014, DIDA Università degli Studi di Firenze por aceptar y apoyar la candidatura de Valencia y en consecuencia la realización del mismo. A la Generalitat Valenciana, Conselleria d'Educació, Formació y Ocupació, al Excmo. Ayuntamiento de Valencia, a la Universitat Politècnica de València, a la Escuela Técnica Superior de Ingeniería de Edificación y a los departamentos universitarios implicados, Cátedra Forum Unesco Universidad y Patrimonio, al Instituto Universitario de Restauración del Patrimonio, a la Escuela Técnica Superior de Arquitectura de Valencia, al Máster de Conservación del Patrimonio Arquitectónico, al Ilustre Colegio Oficial de Arquitectos de la Comunidad Valenciana y al Ilustre Colegio Oficial de Aparejadores, Arquitectos Técnicos e Ingenieros de Edificación de Valencia, a los patrocinadores, a todos aquellos que han contribuido y colaborado para que el congreso fuese una realidad y un agradecimiento de forma destacada a los participantes, por su sensibilidad e interés por los temas tratados, ya que, con una mirada nueva, reconocen el valor por el patrimonio arquitectónico, urbanístico y paisajista construido.

Valencia, septiembre 2015

El Comité Organizador del III Congreso Internacional Documentación, Conservación y Reutilización del Patrimonio Arquitectónico y Paisajístico ReUSO 2015 Valencia

PRESENTACIÓN

En Junio del año 2013 se celebró en la Escuela Técnica Superior de Arquitectura de Madrid la primera edición del Congreso Internacional que ahora nos ocupa y que con el nombre de La experiencia del ReUSO trataba de intercambiar experiencias y criterios sobre nuevos usos en los espacios arquitectónicos. Esta iniciativa compartida con el DIDA, Dipartimento di Architettura de la Facultad de Florencia, pretendía la repetición del evento en la ciudad italiana tal y como sucedió en el mes de noviembre de 2014, donde además se incorporaban en el título de la convocatoria dos palabras, *conservazione e recupero*, que daban mayor amplitud a la convocatoria motivadas por la diversidad de propuestas presentadas y tratadas en Madrid. Florencia, como no podía ser menos, fue un éxito de participación y sirvió para comprobar de nuevo el interés de las secciones del Congreso, a nivel europeo y mundial, por lo tanto no podíamos (y aquí es en origen donde interviene Valencia), dejar cerrado un evento entre dos Universidades amigas con las cuales desde hace años venía colaborando personalmente... queríamos más. Se aceptó la propuesta de Valencia, Universitat Politècnica de València y en este caso, una escuela tecnológica como es la Escuela Técnica Superior de Ingeniería de Edificación, para organizar la III edición del Congreso, abriendo una nueva etapa de futuras sedes. Por ello con gran satisfacción puedo anunciar la continuidad del evento para el próximo 2016 en la ciudad italiana de Pavía, quedando a la espera nuestra querida ciudad de Granada para el 2017, a las cuales les deseamos éxitos futuros. El Programa como en las ediciones anteriores es variado en cuanto a temas y secciones, incorporando en Valencia como novedad la sección 6 relativa a la intervención sobre el patrimonio histórico y la experiencia educativa. Todas las escuelas arriba mencionadas, reflejan en sus programas docentes asignaturas sobre intervenciones en edificios históricos, por lo que pensamos que inculcar la pasión por los temas del Congreso ya desde las aulas, es algo que dará sus frutos tanto en la concienciación hacia la sensibilidad a la hora de actuar sobre estos edificios, como en la apertura de nuevos horizontes profesionales. Asimismo, también se incorpora la compatibilidad de la eficiencia energética, aspecto fundamental hoy en día para una rehabilitación eco-eficiente. Las demás secciones que componen la estructura del congreso abarcan prácticamente la totalidad de cuestiones en el campo de la conservación y recuperación y no solo en el campo edificatorio, es necesario considerar los aspectos urbanos, los paisajes, monumentos y entornos. Esta edición de las Actas en formato digital y que responde al gran número de contribuciones presentadas, (cerca de trescientas treinta), no hace más que corroborar la necesidad, ya citada, de continuar con futuras ediciones que dejen un camino trazado para los profesionales, expertos, investigadores, docentes, estudiantes e interesados en general, quienes a través de sus intervenciones pongan en valor el patrimonio existente, y ante el trabajo realizado nos haga pensar: valía la pena.

Valencia, septiembre 2015

Luis Palmero
Director

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III Congreso Internacional sobre Documentación, Conservación, y Reutilización del Patrimonio Arquitectónico y Paisajístico | VALENCIA 2015

HISTORICAL CHARACTER AND ADAPTABILITY TO ENERGY EFFICIENCY PERFORMANCE IN THE RECOVERY. TWO CASE STUDIES IN FLORENCE

CARATTERE STORICO E ADATTABILITA' PRESTAZIONALE PER UN RECUPERO ENERGETICAMENTE EFFICIENTE. DUE CASI STUDIO A FIRENZE

Paola Gallo[1]

University of Florence, School of Architecture, Department of Architecture (DIDA)[1]

ABSTRACT

A renewal energy project on the historical buildings, with introducing innovative technologies and components that ensure optimal performance, open a difficult question on the evaluation if, technologies for energy savings and/or use of renewable energy, are a "threat" for the building, even if these innovative interventions contribute effectively to the preservation of existing historical buildings and then to the preservation their cultural value.

To overcome this different cultural vision, the challenge is to pursue a more coordinated and cross-sectoral planning, together with a decision-making process based on a holistic view of the built environment.

The paper present two case studies that have pursued this objectives; two projects of buildings recovery, both funded by the European Commission in the Framework Programmes, with relevant interventions of renewal, respecting their historical characteristics, with the aim of improving the performance characteristics for their conservation.

Keywords

Energy, efficiency, energy, recovery, energy saving.

1. INTRODUCTION

The built environment has a central role in our society: buildings are not just the place where we live and work but the building sector is also an important segment in our economy. Yet, the energy performance of existing buildings is poor so that they are responsible for a large share of the overall energy consumption (40% within the EU) and they are also one of the most significant sources of greenhouse gas emissions (36% within the EU).

Thus, buildings are also relevant for the achievement of the energy and climate objectives of the European Union (EU) for the future (2050).

Considering that the average life span of a building is over 50 years and that a complete renewal of the existing building stock would take about 100 years, investing in building refurbishment is crucial to reduce energy consumption and greenhouse gas emissions in the EU. In fact, it is important to achieve the EU energy and climate objectives, it is necessary to refurbish all[1] (or almost all) buildings by 2050.

In detail, historic buildings today play an important role for the community compared to what happened in the past. Such buildings, in fact, beyond their beauty and recognition of their value, are essential as the bearers of our historical identity. Cultural heritage is a significant force for 21st century Europe; not only is it at the heart of what it means to be European, it is being discovered by both governments and citizens as a means of improving economic performance, people's lives and living environments.

The need to recovery, in terms of energy, the historic building heritage and therefore the possibility of introducing innovative technologies and components that can ensure optimal performance, however, pose the difficult question on the evaluation if intervention technology to reduce energy consumption and/or the supply of renewable energy, is to be considered a "threat", while acknowledging that effectively contributes to the use and the long-term preservation of an existing historic building and then to the preservation of its cultural value.

Additional questions, such as preservation and aesthetic aspects, arises. In fact, individual solutions have to be found with advantages and disadvantages which cannot be weighted clear without ambiguity, since it is a widely interdisciplinary field.

There are many techniques available today, which are originally developed for new buildings in order to enhance comfort and energy efficiency for several building typology (dwellings and non-residential buildings).

So, a lot of lessons learnt from low energy and passive houses in terms of new buildings can be transferred to the wide field of refurbishing and retrofit. In fact, the basic principles of building physics are valid for both, but individual solutions have to be found, to adapt all the technical procedures as well as the available products, to the energy recovery of historical buildings.

The paper present the available solutions for energy retrofit of two historic buildings in Florence; the objective is to find out the open questions stimulating the discussion thought this case studies and illustrate expertise of different approaches.

2. CONTENTS

Before starting to refurbish an existing building it is fundamental to carry out an analysis of the actual existing building's performance and condition to understand which areas need to be improved to achieve current benchmarks in term of energy saving, comfort, security and life safety. A baseline can be established by conducting an accurate audit, carried out as a systematic examination and measurement of key aspects of all the building. The main aspects to be considered are energy consumption, occupant satisfaction, facilities management operations, indoor environmental quality, water consumption, waste generation and not least, the necessity to preserve historical parts of the building (Pfluger R., Baldracchi, P. 2011). In detail, it is important to understand the past of the building with regard to its function and to all the changes brought out during its life from structural, envelope, electrical and mechanical systems point of view. After the audit it is possible to establish targets and goals and the appropriate level of refurbishment based on the building condition and level of refurbishment required.

This paper presents results of the architectural and energy retrofitting of two case studies in Florence, carried out applying appropriate and strategic low-energy and sustainable techniques and of the monitoring campaign (IAQ, thermal comfort, light, acoustic) performed first to evaluate the existing situation and then to verify comfort parameters and the energy consumption after works. Either case studies, the Bardini Museum, that the new offices for A. Mayer Paediatric Hospital, was, financed by EU Commission in the FPV Programme. The results of this projects are to provide with a direct guidance, complete with architectural and engineering examples, for design professionals and authorities, setting a new standard for energy consumption in museum and offices buildings. In parallel, it has aimed to disseminate effective information for designers and local authorities and to demonstrate the efficiency of the measures in order to promote them in efficient market promotion, penetration and utilization.

2.1 The Bardini Museum project

The case study of Bardini Museum in Florence participated to MUSEUMS project (NNE5/1999/20). The first intention was to demonstrate that an energy efficient and sustainable museum building design can fully meet the architectural, functional, comfort, control and safety requirements, but the main objective was to apply and test new and innovative technologies in museums in order to achieve total energy savings of over 35% (for retrofit) and reduce CO_2 emissions over 50%, directly contributing to the preservation of European cultural heritage and to the acceptance of innovative and renewable technologies in public buildings.

The Municipality of Florence, Italian Partner of the project, selected the Bardini Museum as case study and paradigm of the Italian Museum Building (Gallo, P., 2007). This historical museum is also one of the most important buildings of the Italian Renaissance, and the intervention of retrofitting has taken account these architectonic and artistic values. This building represents one of the most important buildings of the Eclectic period, and it was projected and realized in 1883 by the Italian architect Bardini restructuring an old church with monastery in order to contain and show his art collection.

Figure 1 The Bardini Museum

The building, north–south oriented, it was naturally ventilated and had no air conditioning system installed. The building has a very heavy structure: in fact, the traditional stone construction is characterized by a massive wall but the older shell had many problems of structural and functional obsolescence as follows:

- obsolete environmental conditions for visitors and staff related to air quality, thermal and visual quality;
- excessive energy consumption; i.e. lighting represented 70% of the total energy consumption due to insufficient and obsolete devices in the exhibition spaces, absence of detectors, absence of day lighting compensation system;
- inefficient use of energy due to bad building maintenance and obsolete equipment;
- damaged windows and windows frames;
- high air infiltration rates;
- inadequate spatial organization of exhibition space.

2.1.1 Elements of the environmental design and innovations in design strategies: building energy performances

The task project was primarily to modulate spaces and services to users' and workers' demand in order to correspond to technological and serviceable requirements, also according to legislative regulations.

Three main scopes have been individualized:

1. Improvement of the building envelope (insulation, glazing, natural ventilation and daylighting techniques) to reduce the thermal losses of the building.
2. Improvement of energy systems used for heating, cooling, ventilation and artificial lighting to decrease the specific energy requirements in each sector.

3. Improvement of control strategies (BEMS, distribution/demand control strategies, intelligent control, etc.) to optimize the performance of the various systems and properly adjust their operation.

Daylight and artificial lighting

The improvement of the old luminaries without efficient reflector was been a very important measure because the surface inside the luminaries should have been more reflective so that more light should have been directed onto the exhibition space (Pohl W., 2009). The use of efficient luminaries with a special reflector can reduce glare and increase illumination levels. This retrofitting measure has provided the required lighting levels with half the number of fixtures, has reduced glare, and increased the illumination levels.

The day lighting level has been optimized by the replacement of existing skylight with new ones. The first step was to change the skylight roofing structure in the main room near the entrance. In place of the heavy glazed roofing, were used luminaries that are transparent 30mm twin-welled polycarbonate panel with a special reflector which can reduce glare and increases illumination levels. A second measure regards the existing wooden false ceiling: all the bulletproof glasses were replaced with special high-transmittance diffuser components made of a high-grade flexible plastic in a position to assure a uniform luminance distribution at the ceiling in the room, apart from a good acoustic.

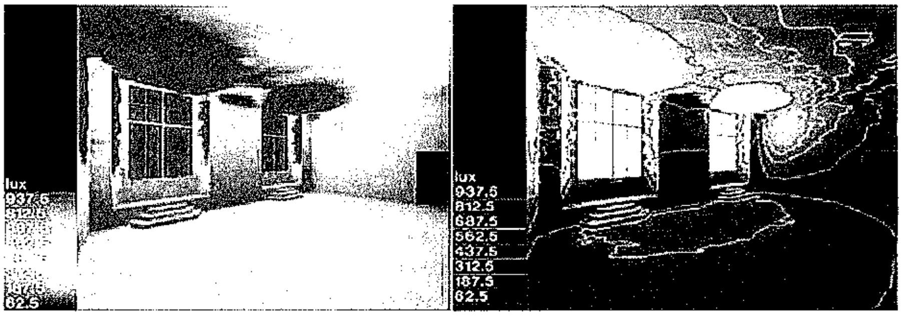

Figure 2 Example of Radiance simulations of "Sala del Terrazzo"

Building performance

In order to complete the energy and environmental design phase, several simulations were performed using validated simulation tools (Esp-r and Radiance) to optimize the design of each specific measure applied in the museum, especially the daylighting improvement measure (Bartolo, R., 2003).

To evaluate the internal comfort of visitors and exhibited materials, particularly to calculate the distribution of the indoor temperatures, as well as the energy required for heating and cooling purposes, Esp_r software has been used. A second simulation was performed to optimize the daylighting design phase. For the evaluation of visual performance, the Radiance tool has been used for the calculation of daylight in interior spaces, the analysis of glare problems, luminance and so on.

These simulations have shown a significant reduction in transmittance using high diffuser in place of the existing glass.

2. 2 The project of Meyer's paediatric hospital offices

The project's global objective of "Retrofitting for Environmental Viability Improvement of Valued Architectural Landmarks"' (REVIVAL) (Gallo, P., Di Stefano G., 2006), was to demonstrate that non-domestic buildings from the post-war pre-energy conscious era, can be refurbished economically, with improvements in energy performance that lead to lower life-cycle CO_2 emissions than the original buildings. The Italian case study, was related to the upgrading of *Villa Ognissanti* that represents the historical hospital complex, into a beautiful park on hills of Florence. The Villa was not suitable to be used as a hospital and was retrofitted and used as reception and contains office for administrative and managerial functions.

Figure 3 The Villa Ognissanti before refurbishment

The overall objective of the Meyer project was to demonstrate that a holistic approach to the refurbishment of existing offices can lead to an energy efficient working environment with optimised energy, sustainability and technological systems and techniques. This approach have ensured maximum possible energy conservation, as well as the best possible indoor environmental quality together with the adoption of more sustainable operational modes.

Fabric refurbishment works included the replacement of the original roof structure and substitution of window frames to reduce air infiltration. In terms of servicing, an HVAC plant equipped with heat recovery was introduced. The project, as innovative design strategy, has integrated a greenhouse with a PV plant incorporated (for the total amount 30 KWp), in front of the central pavilion that works as a buffer zone in winter, to minimize heat losses, and also to increase natural ventilation through a stack effect; thus reducing cooling demand and associated energy costs. In fact, the main objective of this project was to design the refurbishment of the offices Meyer Hospital building, according to the principles of energy efficiency, minimum environmental impact and best integration of energetic technologies into the architectural context.

2.2.1 The greenhouse: high energetic efficiency measure

The greenhouse plays an important role among energetic strategies adopted in this project: in fact it is a buffer space as it gains heat from the adjacent rooms as well as from solar radiation. On sunny days in spring and autumn the greenhouse temperature rises above that of adjacent offices. In this condition, overall when such times coincide with occupancy and heating schedules, the greenhouse makes a net contribution to space heating: up to 17 % of the total heating loads. Occupants not only have the benefit of lower energy bills but also it can be a most comfortable area of the building on sunny winter days. This is due to the large area of contact between greenhouse and parent buildings and to the thermo-physic characteristics of transparent elements of the greenhouse.

The project is a pilot action for the development of the semi-transparent PV technology and represents the first significant example in Italy (Gallo P., 2009): useful and successful collaboration between architects, engineers, PV producers and company experts has allowed the experimentation of innovative PV technologies integration, improving their market penetration in Italy. Thus, this demonstration project is definitely necessary as it will be used to set up future standards for sustainable building designs. By doing this assessment and establishing of best practices, the project may lead also to a first step in the development of norms and regulations for use in National and European scale.

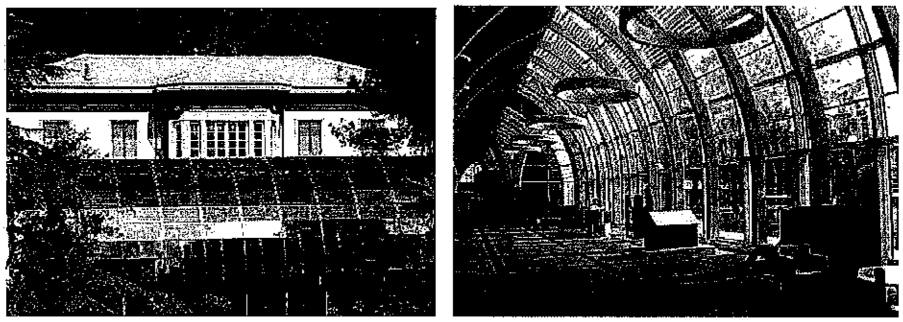

Figure 4 The PV greenhouse

Building performance

Simulations have been conducted to assess the potential for natural cross and night ventilation through the greenhouse. Advanced control strategies have been adopted in order to measure, monitor and record the internal conditions. Moreover, during construction, sustainable practices such as reduction of the use of primary raw materials and recycling of construction related waste were applied, together with an evaluation of the environmental implications relating to the use of ecological materials (availability on the market, procedures of setting up, etc.). A procedure for life-cycle analysis were developed early in the project to assist the prioritising of various environmental measures. This greenhouse, has had a value not only for the significant energy reduction of the adjacent buildings or for the PV system integration in an existing architecture but also for its social effect: the improvement of the working and conditions for staff and consequently quality of life have a big payoff whenever an office is turned into a eco-building office. The pay back of any expenses is often much quicker than projected because of a great increase in employee productivity. Finally, the application of new products and new technologies (Gallo P., 2013) developed into the framework of this project have assessed efforts of the European industry into commercialize these products, and have permitted a better penetration, of solar and energy efficiency products, into the building sector in Italy.

3. CONCLUSION

This two demonstration projects have had aims to contribute to significant decrease in energy consumption and peak electricity demand for lighting, as well as to obtain a considerable improvement of comfort and indoor conditions through the application of high energy innovative measures. In parallel, they were aims to disseminate effective information for designers and local authorities and to demonstrate the efficiency of the measures in order to promote them in efficient market promotion, penetration and utilization.

The qualitative impacts obtained are as follows:

Environmental impacts. Important indirect environmental benefits were obtained with the reduction of CO_2, CFC and the reduction of pollution caused by the use of electricity and thermal energy; furthermore, the application of retrofitting measures have improved of indoor air quality, and allowed the correct level of thermal comfort avoiding the health hazards resulting from inadequate indoor conditions.

Health impact. Application of retrofitting actions have contributed to improve indoor air quality, avoiding health hazards.

Social impacts. Application of retrofitting actions has had a significant impact by creating healthy and comfortable indoor environment and increasing the diffusion of sustainable consciousness in users and owners.

NOTES

1. Following the definition of the Energy Performance of Buildings Directive (EPBD), certain buildings are exempted from the regulation of renovation: first, officially protected historical buildings or buildings of architectural merit; second, places of religious activity and worship; third, industrial buildings used for less than two years; fourth, buildings used in less than four months of the year or consuming 25% of the energy they would need for whole-year operation; fifth, stand-alone buildings having a floor area less than 50 m^2 (EU, 2010a).

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